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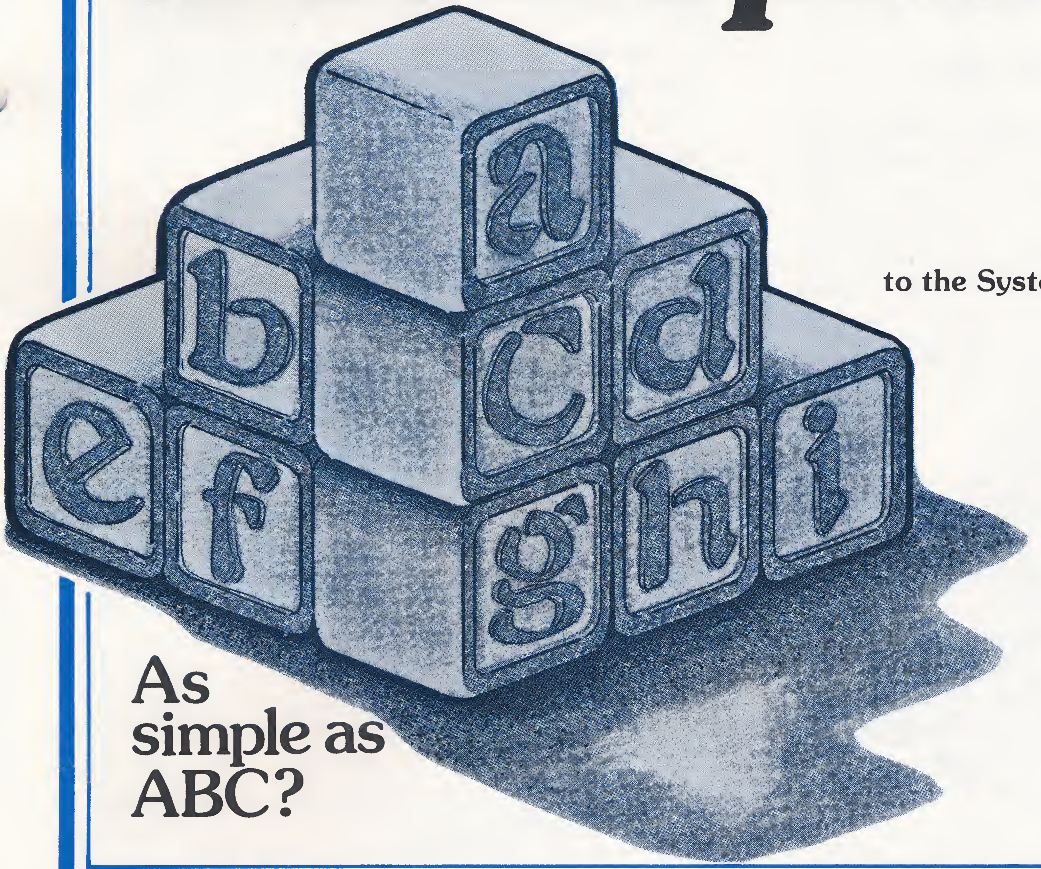
Systems Development



As simple as ABC?

Systems Development — As Simple As ABC?

Editorial

True or False: Buying a computer system is really very simple. First, find out how much you can afford to spend. Call a few companies and arrange for demonstrations. Then, after choosing the computer you like best, have it programmed. Presto, a new system is ready for installation as the heartbeat of your corporate enterprise. Easy, right?

Wrong. Such a course of action practically guarantees disaster. Yet seat-of-the-pants planning for the development of new computer systems is the single, most common error made by managers who rush to acquire the latest fruits of data processing design. Even among those who recognize the dangers of hasty planning, inadequate analysis of the operational requirements of a new system often leads to disappointment or difficulty when the end result is tested. As a consequence, time and money are wasted, inter-departmental squabbles thrive, and management review degenerates into finger-pointing.

Hardware Costs Only 20%

First of all, we need to fully appreciate the reality that the cost of computer hardware represents *only about 20 percent* of the total startup costs of a new system. After all, a computer is, by itself, useless. Only when software development, personnel, management involvement, documentation, and training are added can we truly claim to have a working computer system. Several of these elements are by themselves even more important than the actual selection of hardware.

Second, we must understand that unless our expectations are fully detailed and our system carefully planned in all respects, we can never hope for complete success. Our system will not fulfill its potential unless every step in its development, from concept to reality, has been taken in accordance with a comprehensive design and implementation program. To proceed otherwise will surely cause us to run afoul of Murphy's law: whatever can go wrong will, at the worst possible moment.

But computer systems are sometimes such behemoths, so mammoth in both size and scope, that we are baffled by the complexity of the problem. Not knowning how to properly take the first step, we rush ahead to a later stage, preferring the "hands-on" approach to system design: start with a few component parts and add or subtract until we get distracted by another task...or until the money runs out.

At other times, our problem is the pace of change. Our need for data processing services may be growing or evolving so quickly that we find it difficult to define the goal. By the time we have studied and quantified the job at hand, it has already become something else. If we are not careful, we end up with the perfect way to solve *yesterday's* problem.

Good Systems Development Is Designed to Accommodate Change

Both of these obstacles need not deter the decision maker from a proper course of system development. The design of a large, complicated system can be approached step-by-step in an orderly fashion. A *good systems development process is designed to accommodate change.* Corporate managers can zero in on the "big picture" while technical details can be delegated to the appropriate specialists. In addition, the entire system can have built-in expandability for coping with rapid increases or changes in system usage.

The key to all of this is the adoption of a set of standardized and proven systems development procedures to ensure that the end users' needs are defined early so the appropriate hardware and software can be selected. The operating system, languages, special applications packages, and other elements of the final system must be specified at an early stage in the development cycle...certainly before implementation has begun and any hardware has been purchased.

Not all proposals for new systems can or should be allowed to proceed through initial review into planning and development stages. Increasingly,

managers realize that the introduction of new information systems is a corporate-level decision similar in impact to a capital-spending program. This is because the system has effects far beyond its initial cost, altering productivity and style of the entire organization. Before the green light can be given, the benefits of the new system must be weighed against factors of cost, disruption, and the expected improvement of service. A good systems development procedure includes checkpoints early in the process at which unsuitable projects can be terminated before they have unneccesarily drained the organization's resources.

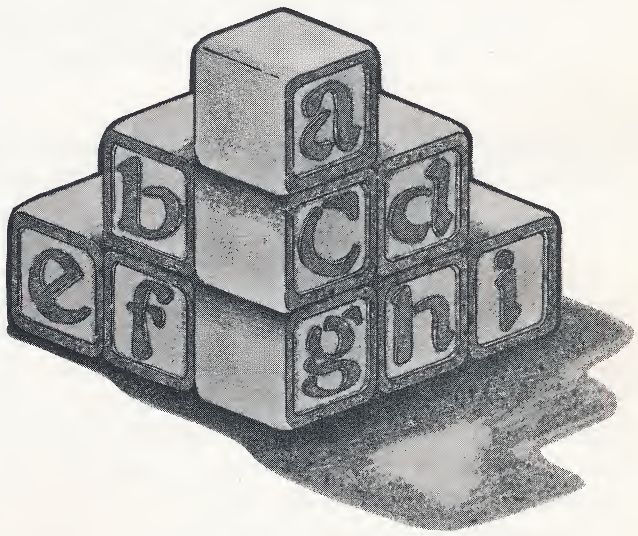
If the go-ahead is given, the systems development plan can proceed from generalities to specifics, with a timetable and a set of specifications which guide the development team along each page. Management is able to review progress at predefined intervals and be assured that the original goals have not been lost in the translation from concept to reality. The procedure assists in the control of costs, schedule, and functionality.

To sophisticates of the industry, the use of a stepwise development procedure is hardly a new idea. After one or two attempts at putting together a new system, they realize the importance of controls and checkpoints. The perils of systems development are likely to ensure that the first-time manager will be more of a realist — and more of a planner — the next time around.

But while some foresight is surely better than none, a comprehensive systems development process is needed which asks all the relevant questions at the right times and of the right people. We really need a sort of road map to guide us through the maze of decisions that must be made on the way to a working system.

In this issue, we are happy to present such an approach. Extracted from ***Managing the Systems Development Process,*** by Charles L. Biggs, Evan G. Birks, and William Atkins of Touche Ross and Company,* the following article outlines the problem and presents a set of steps and phases needed during the development cycle. We present this portion of the book, prior to its publication next year by Prentice-Hall (with permission of the publisher) as a benefit of association membership. The ideas contained in the article are of great significance to all of us; they are not widely known, and it is well worth the effort to become familiar with them.

Even with a good plan of action, we can hardly expect the systems development process to be as simple as ABC. After all, Murphy's Law has not yet been repealed. But though the journey from concept to finished system is long and sometimes arduous, we can surely eliminate the unwanted side trips that make it an unneccesarily treacherous path. And, most important, we can be assured of reaching our goal — a smooth-running new information system, designed from the beginning for success. hs



*Special thanks to David Wilson, ACU's Time-Sharing Section Chairman, for bringing this manuscript to our attention.

Introduction To The Systems Development Process
A Primer For Users

By Charles L. Biggs, Evan G. Birks, and William Atkins
Touche Ross & Co.

There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the initiator has the enmity of all who would profit by the preservation of the old system and merely lukewarm defenders in those who would gain by the new one. This was written in the year 1513 by Machiavelli and continues to hold true today for those who strive to develop new systems.

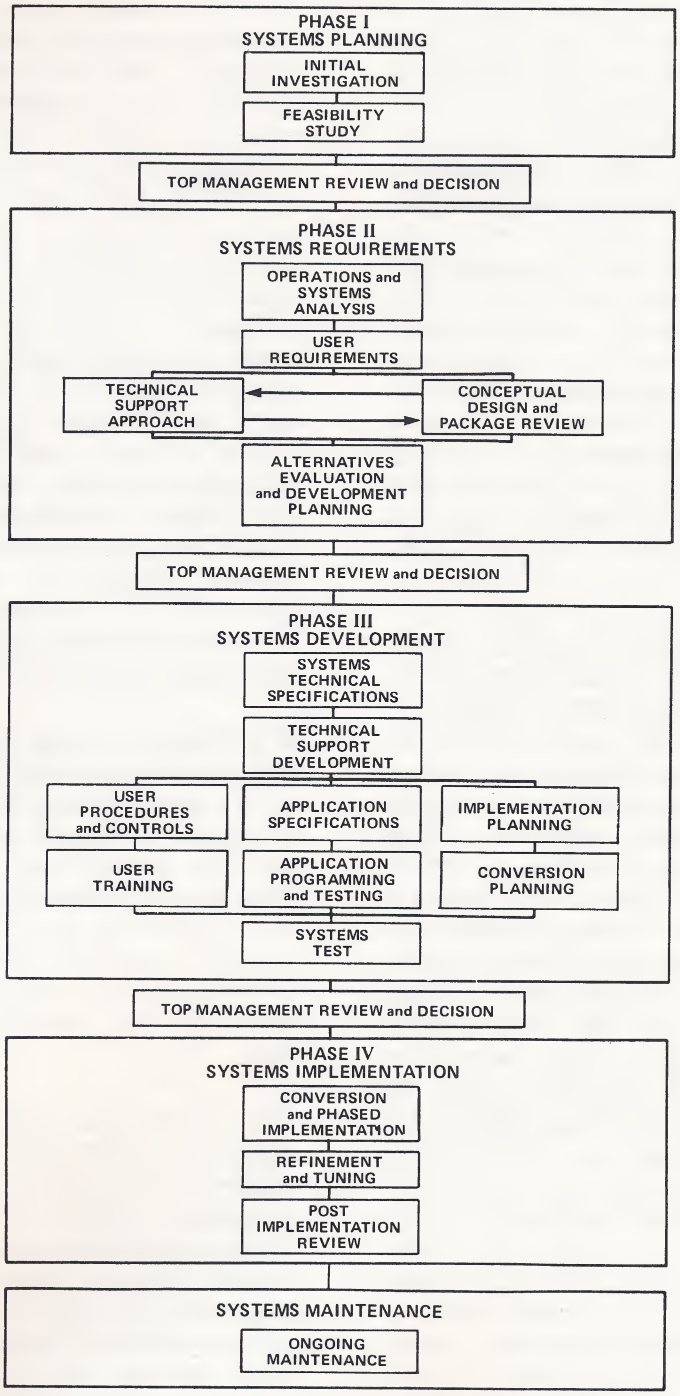
Over the last few decades, most new systems have involved automated data processing techniques. Starting with the early punched card tabulating machines and progressing to today's sophisticated general purpose, mini and micro computers, the term "system" has gained a broad spectrum of usage and meaning. Hence, we have grown familiar with terms such as: IBM systems, data entry systems, operating systems, data base management systems, telecommunications systems, and many more. The context in which we use the term in this article is in the general sense applying to all of the components which make up a system, i.e., the people, policies, practices, procedures, and processing techniques.

It is important for the manager not to lose sight of the many aspects which must be considered when developing a new system. It is not just a technical computer process; to the contrary, it often drastically affects and changes the basic fabric and operation of the organization. Therefore, the manager responsible for developing a new system must be more than a skilled technician applying his trade. The manager must deal with the organizational, operational, and economic considerations, as well as the technical considerations.

In the early years of computerized data processing (the late 1950's and early 1960's), the vast majority of business "systems" were intra-departmental financial applications which had been designed for and converted from unit record punched card systems. Many of the early general purpose computer systems did not have magnetic tape or disk storage and were simply a faster method for processing the punched cards, making the computations, and printing the reports in one step. These application systems, much as the earlier unit record punched card systems, were economically justified on the basis of eliminating steps and clerical effort. As computers became more in vogue in the early 1960's, management went through a subtle change in their decision making related to EDP (electronic data processing). The change related to a shift away from requiring economic justification prior to embarking on new application systems development projects or on upgrading computer hardware. Management seemed to take the position that even though they would not necessarily save money, the use of computers would represent an improved method of operation and provide for future growth. When economics were considered, they were often relegated to future cost containment. At the same time, data processing personnel were mostly specialized technicians programming and operating the computers. They showed few signs of being able managers and in general followed the direction and recommendations of the computer manufacturer's sales personnel. Management, during this period, tended to abdicate its responsibility for EDP due to a lack of technical understanding presumed to be required.

As the middle era (the mid-1960's through the mid-1970's) of computerized data processing arrived, it was heralded by third generation computers which were to provide comprehensive MIS (management information systems). These general purpose computers with miniaturized solid logic technology and integrated circuits captured the attention of most management in larger organizations, who by now felt compelled to keep current with the ever-changing world of computers and data processing. The concept of the new MIS crossed organizational lines and integrated all information elements necessary for timely management decision making. To achieve this concept, the development and implementation strategy in most cases was to convert the existing application systems to operate on the new computers and concurrently begin planning for an integrated MIS. Needless to say, few MIS projects were ever completed. In the meantime, increasing volumes and new application systems, combined with less processing throughput than anticipated, caused healthy growth for the computer manu-

THE SYSTEMS DEVELOPMENT PROCESS



facturers.

In the 1970 recession, the future promise of the computer was for the first time insufficient to maintain the pace of demand. Management seemed to be taking a second look and asking how to get more results for the cost. Third party leasing companies rapidly appeared and experienced significant growth by being able to offer 10 percent, 15 percent, 20 percent, and more savings on computer equipment. However, these savings provided only temporary relief from the ever increasing costs of EDP. Data processing personnel were beginning to face the demands of being managers. They were being asked to justify expenditures, to get more results from the costs being incurred, to reduce costs, to provide reports on a timely basis and to explain the seemingly inescapable cost and time overruns on application development projects and hardware conversions.

In the late 1970's and early 1980's, we appear to be in a new era. This new era is one that will be characterized by *management*—management that effectively utilizes computer technology to achieve cost effective results. For example, mini-computers and microcomputers have proven themselves technologically, and the capability exists for efficient teleprocessing over computer controlled communications networks. The data capture and data entry technology exists to provide more efficient and accurate input. Vastly improved efficiency is becoming available in operating systems software, data base management software, and programming languages. Yet with all this technology, many of the application systems being processed today have not been resystematized or substantially redesigned to be cost effective in this new era.

The Nature Of The Problem

The fundamental problem in early computer systems development projects was that they were considered to be mostly technical and, therefore, were almost completely turned over to technically trained computer personnel. Little thought was given to the needs of the user and the environment the new computerized application system would be serving. In many cases, technically successful computer system projects were operationally cumbersome and difficult for the users, and they never achieved the originally forecast results. During the middle era, computer system projects were becoming increasingly complex, crossing organizational lines, and affecting the traditional methods of operation.

One of the primary reasons underlying the often unfulfilled promise of computers and data processing is the lack of understanding and effective practice of basic management techniques by systems and data processing personnel. Even the rudimentary fundamentals of management (planning, organizing, executing, measuring, and correcting) are often not able to be articulated or demonstrated to be in tangible existence by systems and data processing organizations. These basic management techniques must be introduced, practiced, ingrained, and enhanced if the promise of the computer is to be fulfilled. These management techniques are integral to successfully *Managing the Systems Development Process.*

The first step to improving the management of the Systems Development Process is to define the thing to be managed in an orderly and logical fashion. This is done with the full awareness that all computer systems projects are different, just as people's fingerprints are different. The definition is made with the awareness that the Systems Development Process could be categorized into its logical components, just as most people's ten fingers can be classified, e.g., two index fingers, one left and one right, etc.

The second step to improving the management of the Systems Development Process is to define a methodology or management process for managing a systems project. This management process is defined so that it can accomodate a wide variety of project planning, measuring, and reporting techniques including PERT, CPM, and many commercially available approaches. These two steps, defining the process to be managed and defining the management process to be utilized, create the bridge connecting general management and technical

resources.

Management should continually be aware of certain exposures that exist whenever systems development activities occur. The more common of these include:

- Exposure to fraud - systems that include deliberate misapplication of transactions;
- Exposure to inadequately defined systems that result in competitive disadvantages to an organization;
- Exposure to projects that consume excessive costs in development or ongoing operations;
- Exposure to erroneous business decisions based on inaccurate, misleading, or untimely information from a new system;
- Exposure to costly interruptions to ongoing business operations that result from insufficiently tested new systems, poor backup and recovery procedures, or inadequate conversion and implementation plans;
- Exposure to systems that produce unacceptable accounting information or inadequate audit trails.

Although implied from the above exposures, it is important to summarize the primary causes:

- Incomplete economic evaluations,
- Inadequate user or technical specifications,
- Systems design errors,
- Unmaintainable application systems,
- No project kill points,
- Poor communications,
- Technical self-gratification,
- Personnel incompetency,
- Temptations for fraud,
- Management abdication.

Existence of these exposures should not deter management in seeking to obtain new information systems for the organization. Rather, awareness of these exposures should encourage management to establish and maintain adequate controls to minimize the inherent risks associated with the Systems Development Process. In general, these controls involve:

- A structured systems development methodology,
- A formalized project management process,
- Adequate systems documentation,
- Frequent management and user reviews and approvals,
- Timely technical reviews and approvals,
- Appropriate auditor participation,
- Comprehensive systems tests,
- Controlled staff hiring and training programs,
- Thorough post implementation reviews.

The systems development process and management controls over this process are the primary elements of the balance of this article.

Where Does This Methodology Fit?

Most organizations larger than the smallest proprietorships and professional groups have begun to develop some interest in strategic planning. In very large complex organizations, planning has often become the competitive difference in the marketplace. Other organizations continue to talk a lot about planning without achieving much in the way of results. Some smaller organizations view planning as having the CEO hold discussions about a decision before it is made public. In any event, there seems to be an emerging agreement that top management should be responsible for establishing long-term objectives; defining general business or operational strategies; and setting specific measurable goals or tactical targets to be achieved within a given time period. The objectives and goals — supported by strategies and tactics — require plans and programs that specifically define what is to be done, when, who is responsible, and what resources are to be applied.

This methodology is appropriate for developing the specific plans and programs called for by the systems projects that support an organization's objectives and goals. It specifically defines the phases of the Systems Development Process — planning, requirements, development, implementation, and maintenance.

Who Should Be Involved?

The Systems Development Process should be integral to supporting top management's objectives,

goals and operating plans. This requires an appropriate involvement by each level of management. Just as it would not normally be expected that the chief executive of an organization would make specific decisions on technical details, it should not be expected that technical personnel and a project team make decisions on the organization's objectives, goals, and operating plans.

In most cases, however, all of the parts of the organization that will be affected should be involved in managing the Systems Development Process. This begins at the top with senior management and includes all levels of management. Generally, senior management establishes the objectives and goals of the programs. Then, middle management conducts programs and projects.

The appropriate organizational checks and balances that normally exist for other operations are also required in systems development projects to reduce the risks of partial or complete failure. In many cases, though, organizations have gone overboard in attempting to get management involvement either directly or on steering committees. Examples of inappropriate top management involvement include: making detailed technical presentations on systems design to management who lack sufficient exposure or background to make a competent evaluation of the result; asking top management to approve the purchase of hardware and software components without proper costs and benefits analyses to support the request; and generally approaching management with technical issues which are not put into proper context with the mission of the overall organization.

As consultants to management, we have stressed for many years the need for "appropriate" involvement in managing the Systems Development Process. In general, top management should view systems plans in the context of objectives, goals, and strategic plans for the organization. In a practical sense, these elements are somewhat interactive and modifications to both occur as they both mature.

Middle management's programs, projects, and operating plans should cause them to have very direct involvement in assessing, approving, and "owning" the systems plans. All of these elements — programs, plans, and systems — should be presented in context to top management for their review and decision. Operating management should then be responsible for the detailed planning, execution, and management of approved systems projects.

All three levels of management require an agreed upon methodology to effectively communicate systems development plans and progress. They should all understand what the phases of the systems project will be, what the standard steps are that will occur in each phase, and what "end items" or results will be accomplished. Then, when communicating between the project team and various levels of management on project plans or status, reasonable understanding should result.

The project team in most cases should include personnel from the user organization, from the technical organization, and from other outside resource organizations as required. In many cases, representation from the user organization is the missing link. Often the systems organization is expected to and tries to make up for this missing element by having a systems analyst be responsible for both the operational and systems aspects of the project. This becomes increasingly difficult as more systems projects address basic business operations such as order processing, logistics management, and production control. These projects require more operations analysis and result in more significant impacts throughout the organization. Requiring a systems analyst to be responsible for both roles seldom accomplishes the results that were initially anticipated. Therefore, a new function has emerged to which we refer as our "operations analyst." The operations analyst is preferably a member of the user organization, but may be a member of the systems group.

The Role Of The Operations Analyst

The operations analyst is the catalyst for and the agent of change for improvements in operations,

systems, and management. The operations analyst works in concert with line management to identify and evaluate opportunities for cost effective improvements and subsequently works with operations management to implement approved recommendations. Clarity of thought and expression coupled with effective interpersonal skills are mandatory. The operations analyst is project oriented and works hands on through implementation to achieve results. Implemented results are the measure of the operations analyst's success even though operations management has ongoing responsibility. The operations analyst's career path is into line management from a background that could include engineering, manufacturing, accounting, finance, or systems analysis.

The operations analyst should have demonstrated capability in: organization and operations; situation analysis and problem definition; operations and systems concepts for problem solving; systems analysis and conceptual design; feasibility analysis and cost benefits evaluation; and systems project management including planning, requirements, development, and implementation. The operations analyst should also have general awareness of: computer technologies needed to solve operating problems; computer systems technical design; systems specifications and procedure preparation.

Due to the variety of definitions of the experience and skills appropriate for the members of a systems project team, the following chart summarizes the

SYSTEMS PROJECT

SUMMARY OF EXPERIENCE AND SKILL REQUIREMENTS

Experience and Skills	Operations Analyst	Systems Analyst	Technical Analyst	Programmer Analyst
General operations and organization	A	B	C	C
Situation analysis/problem definition	A	B	C	C
Systems concepts/problem solution	A	B	C	C
Systems analysis/general design	A	B	C	C
Cost benefits/feasibility	A	B	C	C
Systems projects planning and management	A	A	C	C
Computer techniques to solve business problems	B	A	B	C
Applications system design	B	A	B	C
Systems specifications	B	A	B	C
Procedures, controls, and training	A	A	B	C
Programming management	B	A	B	B
Systems testing	A	A	B	B
Systems conversion	A	A	B	B
Technical specifications	C	B	A	A
Programming and testing	C	B	A	A
Hardware evaluation and selection	C	B	A	B
System software evaluation and selection	C	B	A	B
Data base design and selection	C	B	A	C
Data communications analysis and network design	C	B	A	C

A = Demonstrated Capability B = General Awareness C = Limited Exposure

general mix that is appropriate. As any project progresses through the various phases and steps, the experience and skill requirements change. This normally results in personnel changes for the project team in order to complete the necessary activities and tasks.

Overview Of The Systems Development Process

The Systems Development Process is a comprehensive guideline for creating new information systems. It is a generalized process that is appropriate for all systems development projects. It is also highly flexible and adaptable to individual situations. Although technical in nature, the Systems Development Process is primarily a business management process that provides a structured approach for a multi-discipline group involved in any project.

The approach to systems development is characterized by breaking down the total job into a series of manageable units, each of which is further broken down into controllable job assignments that can be defined, analyzed, evaluated, and budgeted with a degree of assurance. Further, the approach recognizes the importance of structuring the individual work segments to produce end products and determining these end items in advance. Uniform, predefined end products do not limit or preclude creativity. They provide instead a consistent structure within which to display creativity. The end products also give management something against which to compare progress and quality. Thus, no matter what the systems project is to produce, there are interim points at which results can be evaluated and measured against known standards.

The Systems Development Process uses a consistent set of terms to describe this top-down approach to breaking the total job into logical, functional parts. The complete development process has four *phases*, each of which has several *steps* containing a group of standard activities. Four phases encompass the entire systems project:

- **Phase I:** Systems Planning
- **Phase II:** Systems Requirements
- **Phase III:** Systems Development
- **Phase IV:** Systems Implementation

At the completion of each of the first three phases, a major end product has been created containing the results of that particular phase and plans for subsequent phases. These products are key factors in management's review, evaluation, and determination of whether or not to proceed to the next phase. A project may be terminated or redirected at each point if it is not economically, technically, or politically viable (or if it is not important enough to warrant the use of available project resources). At the end of the fourth phase, the new system is in operation and an evaluation is prepared for management to review actual versus planned results. A fifth "phase" —Systems Maintenance — contains the repetitive process used to maintain and enhance a system after it is installed.

Within each phase, a series of steps exists each of which is a logical part in accomplishing the objectives of the particular phase. The approach emphasizes controllable work units that can be defined, analyzed, evaluated, and budgeted with a degree of assurance. In addition, it is structured to produce predefined end products that document results and provide a basis to measure progress and quality.

Phase I - Systems Planning begins the Systems Development Process by formalizing conceptual changes and requests received for new systems. The feasibility of pursuing further development is determined through identification of the probable characteristics, costs, and benefits of implementing the requested system. The phase ends with a decision to terminate or approve the next phase. The steps in Phase I are:

- **Step 1** : Initial Investigation
- **Step 2** : Feasibility Study

Phase II - Systems Requirements provide the detailed foundation upon which the technical programs and procedures will be developed. Its primary emphasis is on user operations and environment. It

(Continued — Page 15)

Terminal Users Move Toward 1200 BPS Interactive Computing

by
Stuart Mathison, V.P.
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In the early 1970's most time-sharing users accessed their computer systems with 110 bps teletypewriter terminals. Later in the 1970's, when 300 bps (bits per second) teleprinter terminals became readily available, users naturally converted from 110 bps to 300 bps. The increase in print speeds meant reduced holding time, and consequently reduced communications and computing costs. Today approximately 90% of the terminals in the U.S. used to access time-sharing systems operate at 300 bps.

It now appears likely that this same migration to higher speed terminals will be the pattern in the 1980's; users are now beginning to move from their 300 bps terminals toward 1200 bps terminals, which are more efficient for time-sharing and other interactive applications. Why is this happening?

There appear to be four principal factors stimulating the migration to 1200 bps terminals:

(1) The availability of low-cost 1200 bps terminals, especially the popular CRT-display models

(2) The availability of full-duplex 1200 bps modems offered by Vadic and the Bell System

(3) The availability of statistical multiplexers, providing low-cost 1200 bps communications service, and

(4) The nationwide 1200 bps public-dial services offered by the Telenet and Tymnet packet-switched networks, also providing low-cost 1200 bps communications service.

Efficiency and Productivity Improved by Use of 1200 bps Terminals

The pattern of data flow in interactive time-sharing gives 1200 bps operation distinct advantages over 300 bps. The typical interactive session consists of a terminal user entering data at a very slow keyboard entry speed, typically one or two characters per second. The host computer responds with substantial amounts of data at the maximum speed the terminal can handle. In terms of character volumes, a typical 300 bps terminal user will enter approximately 2,000 characters during a one-hour session, and will receive approximately 20,000 - 30,000 characters of data from the computer. With this typical data flow pattern, the terminal will be printing (or displaying) the data for approximately 15 minutes of each hour.

A terminal operating at 1200 bps requires less than four minutes to print or display the same output data. So switching to a 1200 bps terminal will reduce the holding time for a given application and character volume by approximately 15-20%. This can be directly translated into dollar savings, since both communications and computer usage costs are based largely on holding time.

Operating at 1200 bps also noticeably increases productivity. The man-machine relationship between the user and the host computer improves immediately, because the user's wait for output is shortened dramatically. He can enter the next command before he has lost his train of thought! Furthermore, a 1200 bps terminal prints at approximately the average reading speed, and therefore eliminates yet another bottleneck between the user and the remote computer system.

Introduction of 1200 bps Full-Duplex Modems

The chief obstacle to 1200 bps interactive computing, until recently, was the unavailability of full-duplex dial-up 1200 bps modems. Until the introduction of the Vadic 3400 modem and the Bell 212 modem, in 1977 and 1978 respectively, full-duplex 1200 bps service was simply not available on a dial-up basis to access time-sharing systems.

Although half-duplex, dial-up, Bell 202 1200 bps modems had been available for many years, they were not suitable for interactive time-sharing applications for two reasons. First, they require the use of costly buffered terminals, which employ a

block-oriented error control protocol; and second, they introduce a fraction of a second delay to "turn the line around" each time the direction of transmission was changed.

Full-duplex transmission is preferred for time-sharing applications for another reason — error control. Since dial telephone lines, which are commonly used to access time-sharing systems, are prone to cause occasional errors in transmitted data, many time-sharing systems use an error control technique called echoplexing. In echoplexing, the data entered at the keyboard is not immediately printed but is transferred to the host computer (or the multiplexer/concentrator) then echoed back to the terminal for printing. This technique allows the terminal operator to verify that the data received by the host computer was the same as the data he entered at the keyboard. Echoplexing requires the use of full-duplex modems on the dial access telephone lines.

Full-duplex communication, in contrast to half-duplex communication, enables the host to provide very responsive, interactive service. The user obtains an almost immediate response when he hits the break or interrupt key or enters an escape character. Host computers can then easily perform such functions as command recognition, and character-by-character text editing with terminals operating in full-duplex mode.

The Vadic 3400 and the Bell 212 full-duplex modems utilize a different set of inter-modem signalling frequencies and are therefore incompatible with one another. Initially, a Vadic 1200 bps modem could only communicate with another Vadic, and a Bell 212 with another 212. However, Vadic has recently introduced a dual-compatibility modem, the Vadic Model No. 3467, which enables a user equipped with either a Bell 212 modem or a Vadic 3400 modem to communicate with the Vadic 3467. This is expected to further accelerate the migration toward the use of 1200 bps terminals.

1200 bps Terminals Getting Cheaper

Cathode Ray Tube (CRT) display terminals consist largely of electronics, rather than electromechanical components. As a result of the decline in the cost of digital electronics over the past decade, there are now many high-speed CRT terminals that cost less than $1,000 in single unit quantities. Most of these can operate at 1200 bps.

1200 bps teleprinter terminals have also been declining in cost, although not as rapidly as the CRT display terminals. Still, there are some applications for which hardcopy output is essential. The teleprinter terminals fill this need. Tables 1 and 2 list some of the more popular 1200 bps terminals in each class.

How the Public Packet Networks Stimulated 1200 bps Communications

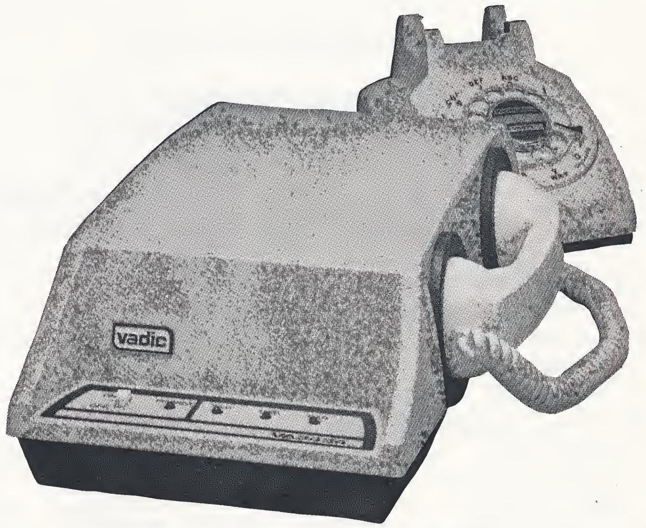
Over the past two years both Telenet and Tymnet have introduced public dial full-duplex 1200 bps service in an increasing number of U.S. cities. Initially public dial-in 1200 bps service utilized the Vadic 3400 modems. When Bell introduced the full-duplex 212 modem in 1978, Telenet and Tymnet offered public dial 1200 bps service supporting the Bell 212 modems as well.

The geographic availability of public dial 1200 bps service on the Telenet and Tymnet networks has continually expanded. As of this writing, both companies offer local dial 1200 bps service in several dozen metropolitan areas, as well as nationwide In-WATS service at 1200 bps. By the end of 1979, most of the cities served by Telenet and Tymnet are likely to provide public dial 1200 bps support.

The communication charge for public dial 1200 bps service in a packet network has two components — a connect time charge and a traffic charge. In the case of Telenet, the connect time charge is $3.25 per hour and the traffic charge is $.50 per kilopacket. A typical 1200 bps terminal user will

send and receive between 1 and 1½ kilopackets per hour, depending on the nature of the application and the total character volume transmitted. Thus, the total hourly cost will be approximately $4.00.

It is significant that Telenet's charges for 1200 bps service are approximately the same as its charges for 300 bps service. The public dial connect time charge is $3.25 per hour for both 300 and 1200 bps terminals; the traffic charge of $.50 per kilopacket is also the same for both. The 1200 bps terminal will transfer about the same number of packets per hour as the 300 bps terminal, but the 1200 bps terminal will typically receive "fuller" packets —i.e., packets containing more user data — and therefore will receive more characters per hour than the 300 bps terminal.



The Racal-Vadic VA3434 acoustic coupler that operates at 1200bps.

What About Stand-Alone Host Systems Supporting Full-Duplex 1200 bps Service?

Host computers not connected to Telenet or Tymnet can support full-duplex 1200 bps terminals if the hosts have dial-in ports equipped with Bell 212 or Vadic 3400 modems, or if the hosts are accessed through multiplexers or concentrators equipped with such modems. This is frequently impractical, however, since to do so using either In-WATS lines or multiplexers is extremely costly and to provide a small rotary of dial-in 1200 bps ports on concentrators would usually be uneconomic due to low dial port utilization. As a result, many interactive host systems offer 1200 bps access only through Telenet or Tymnet.

Hosts connected to the public packet networks can support full-duplex 1200 bps terminals if the hosts interface to the network using the international standard X.25 protocol, or if the hosts are connected to the network utilizing 1200 bps terminal emulation interface ports. Most emulation interface ports utilize flow control techniques, such as the "transmit-on" and "transmit-off" characters (X-on/X-off) in order to prevent data overflow, and to permit the same 1200 bps host ports to be accessed by lower speed terminals (110-300 bps) as well.

1200 bps Terminals are a Sure Bet for the 1980s

1200 bps terminals offer so many advantages for interactive computing — the reduction of computing and communications costs and the simultaneous improvement of user productivity, for example — that their prevalence is bound to grow.

At the same time, the migration toward these higher-speed terminals is making new business-oriented applications feasible for the first time. Applications that involve outputting lengthy reports and/or long text files can be accomplished quickly and economically. Also, applications designed for the non-computer-oriented user will proliferate, since the lengthy, English-like prompts and user-assistance statements can be accommodated without introducing substantial delays.

Even though most portable, acoustically coupled terminals will probably continue to operate at 300 bps for some time to come, within the next few years the majority of interactive computing applications may well be performed using 1200 bps CRT display or teleprinter terminals.

Table 1

CRT Display Terminals Which Operate At 1200 BPS

Make/Model	Approx. Single Unit Price
AT&T Dataspeed 40/2	*
Applied Digital Data Systems (ADDS)	
Consul 520	$1,600
Consul 980	$2,800
Regent 200	$1,800
Beehive International	
Micro Bee	$1,000
Micro Bee 1A	$1,400
Micro Bee 2	$1,700
Datamedia Corporation	
Elite 1520	$2,500
Elite 1520 Portable	$2,500
Elite 1521 A	$1,200
Hazeltine	
1400	$ 825
1410	$ 900
1420	$1,000
1500	$1,200
1510	$1,300
1520	$1,600
Modular 1	$1,600
Hewlett-Packard	
HP 2640 B	$2,600
HP 2645 A	$3,500
HP 2649 A	$2,150
Infoton	
I-200	$1,200
I-400	$1,500
Lear-Siegler	
ADM-3A	$ 895
Perkin-Elmer	
Model 1100	$1,500
Owl 1200	$2,200
Research Inc.	
Teleray 3541	$1,200
Teleray 3741	$1,300
Tektronix	
4024	$3,000
4025	$4,000

*Price for AT&T Dataspeed 40/2 depends upon local telephone company

Table 2

Teleprinter Terminals Which Operate At 1200 BPS

Make/Model	Approx. Single Unit Price
Anderson Jacobson AJ 860	$2,800
Digital Equipment Corp. (DEC) LA 180	$3,000
DI-AN Controls Series 30 KSR	$2,200
Execuport 1200	$3,500
General Electric Terminal 1200	$2,000
Lear-Siegler Model 220	$1,750
Logabox dXL 180/KSR	$4,000
Teletype Model 40/2 KDP	$4,900
Texas Instruments 820 KSR	$2,400
Xerox 1760	$2,990

(The Systems Development Process — Continued from Page 10)
ends with another review and decision to terminate or proceed to the next phase. The steps in Phase II are:

- **Step 1**: Operations and Systems Analysis
- **Step 2**: User Requirements
- **Step 3**: Technical Support Approach
- **Step 4**: Conceptual Design and Package Review
- **Step 5**: Alternatives Evaluation and Development Planning

Phase III - Systems Development begins with an accepted conceptual design approach and ends with a completely developed new system that has been thoroughly tested and prepared for implementation. For many projects, this phase may be repeated several times in order to develop multiple subsystems identified in the previous requirements phase. Purchase of an application package generally reduces the scope of work in this phase but seldom completely eliminates any step. Phase III ends with a review of development and testing results and an agreement by all parties that the new system should be implemented. The steps in this phase are:

- **Step 1**: Systems Technical Specifications
- **Step 2**: Technical Support Development
- **Step 3**: Applications Specifications
- **Step 4**: Applications Programming and Testing
- **Step 5**: User Procedures and Controls
- **Step 6**: User Training
- **Step 7**: Implementation Planning
- **Step 8**: Conversion Planning
- **Step 9**: Systems Test

Phase IV - Systems Implementation contain the actual initiation of new programs and procedures and the termination of old processes. For many projects, this phase is repeated several times to implement multiple subsystems or to install the system in multiple locations. The steps in Phase IV are:

- **Step 1**: Conversion and Phase Implementation
- **Step 2**: Refinement and Tuning
- **Step 3**: Post-Implementation Review

Finally, it is important to remember that the Systems Development Process as introduced in this article is intended to be a guideline, not a rigid set of instructions. The standard approach explained here makes it possible to plan, control, and evaluate progress during the Systems Development Process without inhibiting the necessary analytical and creative work required to produce successful new systems. In addition, this structure allows management to make and monitor incremental commitments, providing the ability to impact interim results. This is an important key to an organization's effective management of the Systems Development Process.

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